WARNING

RA PD 404264

HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections or 115 volt ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

EXTREMELY DANGEROUS POTENTIALS

greater than 500 volts exist in the following units:

Antenna coupler
Control-oscillator group
  Modulator power supply
  Pulse amplifier-modulator
  +250v, +170v, +120v, or –150v power supply
  –1000v power supply
Electron tube storage rack
  Spare klystron ion pump power supply
Electron tube truck
  Spare klystron ion pump power supply

High voltage power supply
High voltage pulse generator
  Amplifier power supply assembly
  Left-hand tube cradle
  Right-hand tube cradle
  Trigger pulse amplifier
Induction voltage regulator
Klystron amplifier
  Ion pump power supply subassembly
Mobile external antenna coupler and coupler extension kit
Power control-indicator
  Oscilloscope drawer
Receiver group
  HIPAR monitor PPI
  Keep-alive power supply
  Noise modulator-power supply
  Parametric amplifier
  PPI high voltage power supply
  Pump power supply
Step-up power transformer
Transmitter control-indicator
  Oscilloscope drawer

Warning: **Do not be misled by the term "low voltage." Potentials as low as 50 volts may cause death under adverse conditions.**

For artificial respiration, refer to FM 21–11.

TECHNICAL MANUAL
No. 9-1400-250-10/2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *29 December 1960*

OVERALL SYSTEM DESCRIPTION (U)

(Next numbered page is 9)

CHAPTER 1 (C)

INTRODUCTION

Section I (C). GENERAL

1 (U). Purpose

This manual presents a general overall description of the Improved NIKE-HERCULES Air Defense Guided Missile System and the NIKE-HERCULES Anti-Tactical Ballistic Missile (ATBM) System. This overall description is intended to provide information for personnel requiring a general knowledge of the system and to serve as indoctrination material for all personnel associated with the system.

2 (U). Scope

a. This manual describes the physical and functional characteristics of the Improved NIKE-HERCULES Air Defense Guided Missile System and the NIKE-HERCULES ATBM System. Included in this description are history of development, system capabilities, site layout, major areas of a site, physical description of equipment, functional description of subsystems, tactical operations during an engagement, and maintenance support.

a.1. This manual provides coverage for the following selected system modification work orders (MWO's).

(1) 9-1400-250-50/9 adds ATBM capability to the Improved NIKE-HERCULES ground guidance system (INH selected systems).

(2) 9-1430-251-30/8 provides facilities for adding radar bomb-scoring equipment to the trailer mounted director station (INH all systems).

(3) (Deleted)

(4) Field change 1003 provides facilities and adds functions for system compatibility with the electronic counter-countermeasures (ECCM) console and auxiliary acquisition radar (AAR) in Improved NIKE-HERCULES systems with dual direct view storage tube (DVST) console (selected systems).

b. This manual is technically correct for all Improved NIKE-HERCULES and NIKE-HERCULES ATBM Systems provided the pertinent MWO's listed in the remainder of this subparagraph have been incorporated.

(1) 9-1400-250-50/5 provides anti-jam display capabilities to the Improved NIKE-HERCULES acquisition radar systems (INH all systems).

(2) 9-1400-250-50/17 incorporates EFS in the HIPAR system (systems 502 through 537).

(3) 9-1400-250-50/28 provides facilities for connecting radar signal-simulator station AN/MPQ-T1 (T1 trainer) and adds functions for annual service practice to the Improved NIKE-HERCULES Systems. It also provides facilities and adds functions for system compatibility with the ECCM console on Improved NIKE-HERCULES Systems having AAR (INH suffix serial numbers 001 through 158, 162, 163, 169, 180, 181, 184, 185, 192, and 196 through 198; dual DVST consoles with suffix serial numbers 1 through 32).

(4) 9-1400-250-50/37 adds facilities for radar signal-simulator station AN/MPQ-T1 (systems 502 through 562, and 564 through 572); adds overcurrent protection to the power distribution unit (systems 502 through 537) and to the power control-indicator (systems 538 through 562); adds three-phase power to the MTI group (systems 538 through 562); relocates components to eliminate interaction (systems 502 through 572);

protects components against the loss of three-phase power (systems 502 through 562); adds a relief valve to the waveguide pressurizer (systems 502 through 562, and 564 through 572); corrects calibration of the noise figure meter (systems 538 through 548); and provides proper traveling-wave tube grid voltages (systems 538 through 549).

(5) 9-1400-250-50/48 replaces liquid cooler 9023721 with pumping unit 9999053 and liquid cooler 9999047 (systems 502 through 537) and refrigerant condenser 9994082 and liquid cooler 9994083 with pumping unit 9999053 and liquid cooler 9999047 (systems 538 through 583); provides for lubrication of the glycol pump motor (systems 538 through 583); adds an X-ray warning plate to klystron amplifier 9994076 (systems 502 through 588); facilitates the draining of the oil in the waveguide pressurizer (systems 502 through 583); eliminates the failure of control amplifier 9987373 (systems 502 through 594); provides positive electrical terminations for the antenna drive motor leads (systems 502 through 594); prevents unintentional misalinement of EFS receiver (systems 502 through 537) and EFS receiver group (systems 538 through 594); provides the proper voltage for the new klystron tube in the EFS receiver (systems 502 through 537) and EFS receiver group (systems 538 through 594); adds new receiver klystron tube filament transformer (systems 502 through 594); provides proper short circuit protection for power supply 9022872 (systems 502 through 537) and power supply 9994359 (systems 538 through 594); increases the effectiveness of decoupling in trigger pulse amplifier 9987106 (systems 502 through 594); prevents spurious outputs from control-oscillator group 9994063 (systems 502 through 594; adds facilities for RF grounding of EFS HIPAR (systems 502 through 537); adds overcurrent protection in power distribution unit 9023180 (systems 502 through 537) and in power control-indicator 9994075 (systems 538 through 594); removes the delay line driver from the moving target indicator group (systems 502 through 537); and changes the temperature regulating valve on pumping unit 9999053 (systems 584 through 594).

(6) 9-1400-250-50/53 incorporates the anti-jam improvement (AJI) capabilities into the HIPAR systems. (HIPAR systems 815 and below).

(7) 9-1430-251-30/37 relocates the ten EFS/HIPAR channel select switches and makes the director-computer group compatible with the AJI HIPAR, replaces power output meter in auxiliary HIPAR control-indicator, and adds AAR control panel to systems with AAR capabilities (INH suffix serial numbers 001 through 316; dual DVST suffix serial numbers 1 through 54).

(8) 9-1430-251-30/39 provides facilities for connecting the AN/GSA-77 battery terminal equipment (BTE) in the director station trailer (INH suffix serial numbers 001 through 316; all dual DVST kits with INH suffix serial numbers 001 through 316).

(9) 9-1430-254-30/2/1 provides additional anti-jamming capabilities to the HIPAR equipment (systems 502 through 514).

(10) Special purpose kit 1430-073-8880 prevents interference between the TD-2 communication system and the low power acquisition radar (LOPAR) (selected systems).

(11) Special purpose kit 1430-740-1500 eliminates television interference in the acquisition radar receiver-transmitter (selected systems).

b.1. For a complete list of MWO's applicable to the equipment, refer to DA PAM 310-7.

c. This is one of a series of technical manuals on operation, emplacement, and maintenance of the Improved NIKE-HERCULES System and the NIKE-HERCULES ATBM System. Refer to DA PAM 310-2 and DA PAM 310-4 for a listing of publications indexes, administrative publications, forms and records publications, supply publications, and NIKE technical manuals.

d. A cross-reference index of technical manual nomenclature and official nomenclature for items of the radar course directing central of the Improved NIKE-HERCULES System and the NIKE-HERCULES ATBM System is provided in TM 9-1430-251-12/3, TM 9-1430-255-12/1, and TM 9-1430-256-12/1.

3 (U). Forms, Records, and Reports

Refer to TM 38-750 for instructions on the use and completion of all forms required for operating and maintaining this equipment.

3.1 (U). Report of Equipment Publication Improvements

Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to: Commanding General, U. S. Army Missile Command, ATTN: AMSMI-SMPT (NMP), Redstone Arsenal, Alabama 35809.

4 (U). Function of Air Defense Guided Missile Systems

The function of air defense guided missile systems is to deter or minimize the effects of enemy attacks by detecting and destroying enemy aircraft and missiles approaching a defended area. These systems must be capable of effective action against targets operating at any altitude and velocity. The systems must also be capable of trajectory corrections after missile launch to permit interception of targets taking evasive actions. In addition, it is desirable that the systems be capable of self defense against tactical surface targets. The Improved NIKE-HERCULES System and the NIKE-HERCULES ATBM System can be used in support of other service groups. A bomb-scoring system incorporated into the Improved NIKE-HERCULES System and the NIKE-HERCULES ATBM System enables tracking a bomb-dropping aircraft up to the bomb release point. Then, using predetermined data, the theoretical impact point of the bomb can be calculated. Thus, bomb-drop accuracy can be measured without the actual expenditure of a bomb.

5 (C). Improved NIKE-HERCULES Air Defense Guided Missile System and NIKE-HERCULES ATBM System

a. The Improved NIKE-HERCULES Air Defense Guided Missile System and the NIKE-HERCULES ATBM System use integrated radar systems to detect and track targets approaching its defended area. A radar system is also used to guide missiles to intercept and destroy hostile targets. Early warning facilities provide information of the approach of hostile targets, and either of two acquisition radar systems provides constant long-range detection and surveillance of the targets. The acquisition radar systems supply target azimuth and range data to the target tracking radar systems, which acquire and track the targets. A missile tracking radar system acquires a missile while it is still on the launcher, tracks the missile in flight, and transmits steering and warhead burst orders to the missile.

b. Target and missile position data are continuously supplied to a computer system. The computer system furnishes to the battery control officer the information necessary for determining the proper time to launch the missile, and sends steering and warhead burst orders to the missile tracking radar system for transmission to the missile during flight. Targets may be aircraft or missiles at speeds up to Mach 3 and altitudes up to 100,000 feet. Both high-explosive and nuclear warheads are employed. Nuclear warheads are for use against large formations of aircraft, tactical ballistic missiles, or surface targets.

6 (C). History of Development

a. The development of offensive missiles and the increases in the capabilities of modern aircraft have rendered conventional antiaircraft

weapons ineffective. The need for a new defense became apparent as fundamental changes in existing defensive weapons seemed unlikely. After an investigation program, it was decided that the most effective defense would be a guided missile system.

b. There were three types of missile guidance systems from which to choose: the homing system, the beam rider system, and the command guidance system. These are described briefly in (1) through (3) below.

(1) The homing system guides the missile by emissions or reflections from the target. The emissions may be light, heat, radio signals, or radar reflections. The accuracy of the homing system increases as the missile approaches the target.

(2) With the beam rider system, the missile must be launched and then captured by a radar beam pointing at the target. The missile must then follow the beam to the target. A number of missiles can be controlled at the same time with this system.

(3) The command guidance system guides the missile by steering commands transmitted from ground guidance equipment to the missile while in trajectory. Complex and precise ground guidance equipment is required for this type of guidance system. However, the expendable missile guidance equipment is less complex than that required for homing or beam rider systems.

c. After an analysis of the three missile guidance systems, it was decided that the command guidance system would best provide the needed defense. The command guidance system promised to be the most effective against fast and highly maneuverable aircraft and to have capabilities for greater range. A government research and development program was initiated that resulted in the NIKE-AJAX Air Defense Guided Missile System, utilizing a command guidance system. The NIKE-AJAX System proved capable of destroying aircraft at ranges up to 50,000 yards.

d. As the speed and maneuverability of modern aircraft increased, it became apparent in 1952 that the NIKE-AJAX System would soon cease to be an effective defense. A new guided missile system was needed which could destroy entire formations of high-altitude, high-speed aircraft at greater ranges with a single missile. After extensive studies, it was determined that this new system would require the use of a nuclear warhead in a new missile having greater range and speed than the NIKE-AJAX missile.

e. Studies were made concerning the feasibility of incorporating a nuclear warhead in the NIKE-AJAX missile to give it the greater destructive capabilities needed. Consideration was also given to changing the NIKE-AJAX ground guidance equipment to get the greater range and accuracy required. It became apparent that adaptation of the NIKE-AJAX missile would necessitate extensive missile redesign, but only relatively minor changes in the NIKE-AJAX ground guidance equipment would be necessary to produce the ground guidance equipment for the new system. In addition, it was determined that the ground guidance equipment could be changed so that it would be capable of launching and controlling the new missile and the NIKE-AJAX missile as well. This would permit retaining the NIKE-AJAX missile for use with the new system against single aircraft at shorter ranges.

f. Surface-to-surface capability for the new system was included as a secondary requirement. Engagement of surface targets at ranges up to 100 nautical miles was desired. Missiles used in the surface-to-surface mission were to be capable of delivering nuclear warheads.

g. In 1954, after studies were completed, contractors were authorized to proceed with development of the new system, designated the NIKE-HERCULES Air Defense Guided Missile System. This system provided the additional capabilities required, including an intercept range in excess of 150,000 yards, more than three times the range of the NIKE-AJAX.

h. In 1956, it became apparent that further improvement to the NIKE-HERCULES System would be necessary to keep pace with advancements in aircraft, air-to-surface missiles, and electronic countermeasures (ECM) tech-

niques. Extensions of NIKE–HERCULES capabilities were needed to maintain effective defense against smaller, faster targets operating at higher altitudes and equipped with improved ECM systems.

i. From inception, the design of the NIKE system was intended to afford maximum performance flexibility with minimum system modification. Studies showed that the basic NIKE–HERCULES System could again be improved to meet the anticipated post-1960 threat. Without changing the missile, effective range of the system could be increased by the addition of a new high power acquisition radar (HIPAR) system. The HIPAR system, plus a new target ranging radar system, could provide electronic counter-countermeasures (ECCM) capabilities to contend with anticipated enemy ECM techniques.

j. In 1958, after studies were completed, contractors were authorized to proceed with development of the new system, designated the Improved NIKE–HERCULES Air Defense Guided Missile System.

k. Later, studies were begun on the feasibility of adapting existing guided missile systems for use in countering the threat to the Field Army by enemy tactical ballistic missiles.

l. Studies of the NIKE–HERCULES System revealed that if changes were made in the HIPAR and computer systems, the Improved NIKE–HERCULES System could be used for defense against tactical ballistic missiles as well as manned aircraft and air-supported missiles.

m. After studies were completed, contractors were authorized to proceed with the development of the NIKE–HERCULES ATBM Air Defense Guided Missile System.

n. The auxiliary acquisition radar (AAR) is added to selected Improved NIKE–HERCULES sites and Improved NIKE–HERCULES sites with dual DVST console which are not equipped with HIPAR. The advantages of the added AAR over a basic radar system are twofold. The range of surveillance of the site is increased and the system is less vulnerable to ECM with the increase of frequencies available.

o. The T1 trainer provides facilities for operating the NIKE–HERCULES System in all tactical conditions by simulating targets, ECM, and system problems. The training of operating personnel is realistic and the status of the system can be accurately determined.

p. The recent development of a mobile HIPAR system provides increased mobility for the Field Army using the Improved NIKE–HERCULES System. The radar set, electrically similar to the EFS/ATBM HIPAR system, is mounted on five trailers and can be march ordered or emplaced within three hours. In addition, the radar set contains its own independent power source which is also capable of supplying the 400-cycle power required by the Improved NIKE–HERCULES System.

q. The AJI modification to the HIPAR system, developed to combat existing and anticipated ECM threats, provides improved ECCM equipment. Since the four AJI subsystems which complete this ECCM package do not reduce receiver sensitivity or degrade system video, they are used as inline fixes. These three AJI subsystems are explained below.

(1) *Automatic jamming avoidance circuits (AJAC).* Electronic programming provides automatic selection of the least-jammed channel as necessary to avoid enemy ECM.

(2) *Automatic cancellation of extended targets (ACET).* Targets which exceed 10 usec in duration (clutter or weather returns) are cancelled by amplitude suppression in these circuits.

(3) *Higher power.* An increase in power provides a higher burn-through capability for selected HIPAR systems.

Section II (CMHA). GENERAL TACTICAL CHARACTERISTICS

7 (U). Application

a. The Improved NIKE-HERCULES Air Defense Guided Missile System is primarily designed to combat air-to-surface missiles and fast, high-altitude formations of modern aircraft with electronic countermeasures (ECM) capabilities. It can be most effectively employed to defend military installations, industrial centers, large cities, and as a first line of defense in areas such as the DEW Line and the eastern and western seaboards of the continental United States.

b. An Improved NIKE-HERCULES battery can be employed as an individual defense unit or in combination with other air defense units. A number of Improved NIKE-HERCULES batteries can be employed as units of an integrated air defense system, with each system monitored and controlled by an Army Air Defense Command Post (AADCP).

c. The NIKE-HERCULES ATBM System is designed to combat aircraft, air supported missiles, and tactical ballistic missiles and can be conditioned to operate against surface targets.

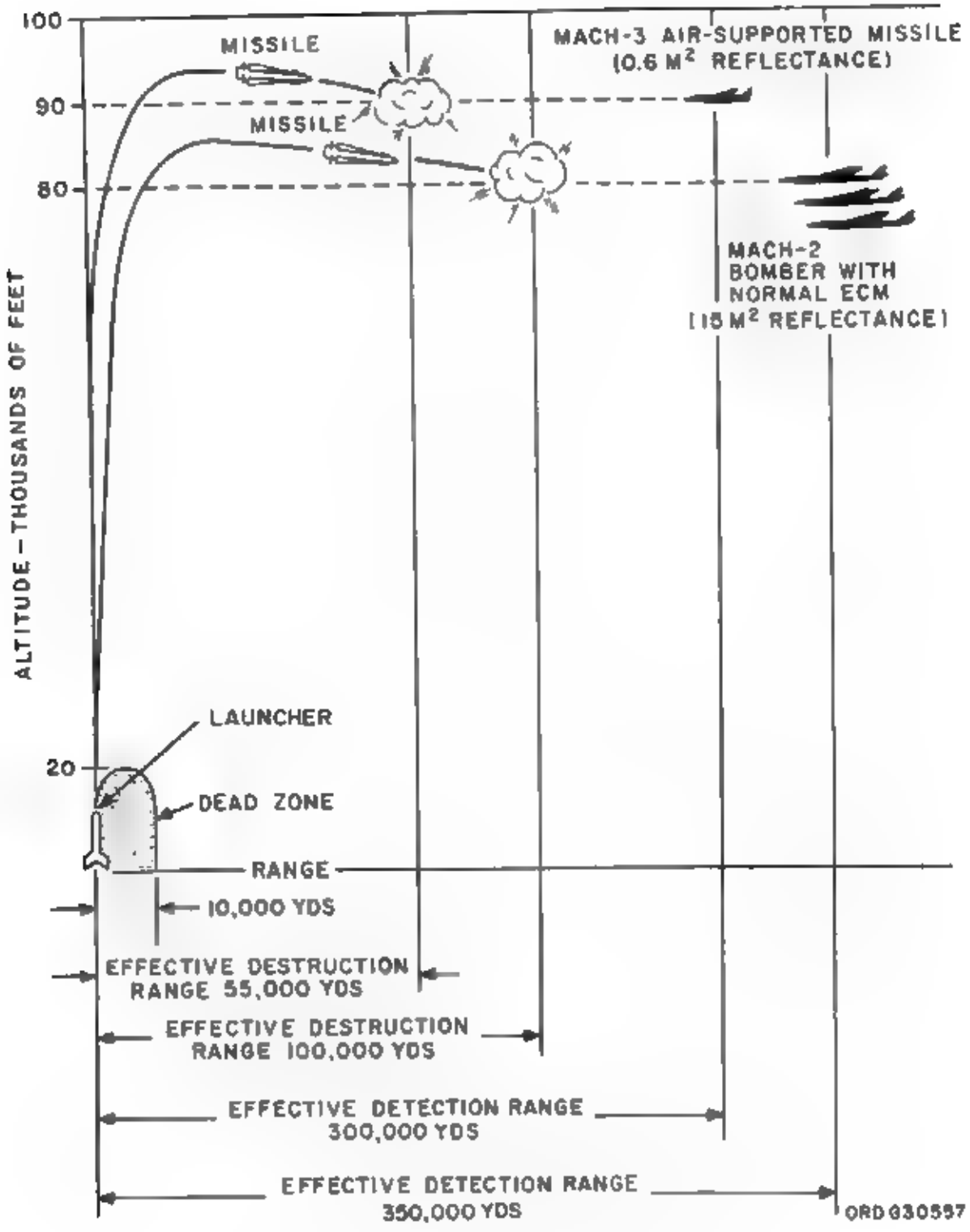

Figure 8 (CMHA). Surface-to-air mission capabilities (U).

8 (C). Capabilities

The Improved NIKE–HERCULES System is capable of performing two types of missions: surface-to-air and surface-to-surface. The system can also be used for radar scoring of simulated bombing runs. The general capabilities of the Improved NIKE–HERCULES System are described in *a* through *d* below.

a. Surface-to-Air Mission (fig. 2).

(1) The Improved NIKE–HERCULES System is designed to combat bombers or air supported missiles at altitudes up to 100,000 feet. The system can detect a missile traveling at Mach 3 with a typical radar reflecting surface of 0.6 square meter at a maximum range of 300,000 yards. Bombers traveling at Mach 2 with normal ECM capabilities and with a typical radar reflecting surface of 15 square meters can be detected at 350,000 yards. At 90,000 feet altitude, the air-supported missile can be destroyed at 55,000 yards range. At 80,000 feet, bomber formations can be destroyed at 100,000 yards. The NIKE–HERCULES missile can attain a maximum velocity of Mach 3.5 which surpasses the speed of known existing manned aircraft or aerodynamically supported missiles.

(2) When a missile is fired in a surface-to-air mission, an intercept cannot be made within a "dead zone" surrounding its launcher. This "dead zone" has a ground radius of approximately 10,000 yards and an altitude of approximately 20,000 feet. The dead zone is determined by the launch angle and the minimum turning radius of the missile.

b. (Deleted)

c. Surface-to-Surface Mission (fig. 4). The Improved NIKE–HERCULES System can deliver a nuclear warhead to a surface target at a maximum range of 100 nautical miles.

c.1. Radar Bomb Scoring Mission. The Improved NIKE–HERCULES System, when used in a radar bomb scoring mission, accurately plots the course of a bomber making a simulated bombing run and marks the point of the simulated bomb release. From this plot the theoretical impact point is calculated, and the accuracy of the bombing run is determined.

d. Operating Conditions. The Improved NIKE–HERCULES System is capable of operating 23 hours a day without impairment of performance, and at least 5,000 hours without major overhaul. The equipment operates efficiently over an ambient temperature range from −40° to +125°F and at relative humidities up to 100 percent. Rain, dust, snow, sand, salt air, and steady surface winds up to 60 miles per hour, and surface gusts up to 75 miles per hour will not interfere with normal operation. The equipment is designed to operate efficiently at altitudes up to 6,000 feet above sea level. The Improved NIKE–HERCULES ground guidance equipment with anti-jam display facilities can operate effectively in the presence of severe jamming.

8.1 (C). Capabilities of The NIKE–HERCULES ATBM System

The NIKE–HERCULES ATBM System is capable of performing three types of missions: Surface-to-air antiaircraft (A–A), surface-to-air anti-missile (A–M), and surface-to-surface. The system can also be used for radar scoring of simulated bombing runs as described in paragraph 8*c.1*. The capabilities of the ATBM system are described in *a* through *d* below.

a. Surface-to-Air Antiaircraft Mission.

(1) The NIKE–HERCULES ATBM System is capable of guiding a NIKE–HERCULES missile to intercept and destroy entire formations of high performance aircraft as well as air supported missiles. Intercept can be made at ranges in excess of 150,000 yards and at altitudes up to 100,000 feet. Targets can be detected at a range of 350,000 yards with the HIPAR/AAR system and 250,000 yards with the LOPAR system. The NIKE–HERCULES missile can attain a maximum velocity of Mach 3.5 and has a maneuverability advantage over all known tactical manned aircraft.

(2) When a missile is fired, intercept can-

Figure 3. (Deleted).

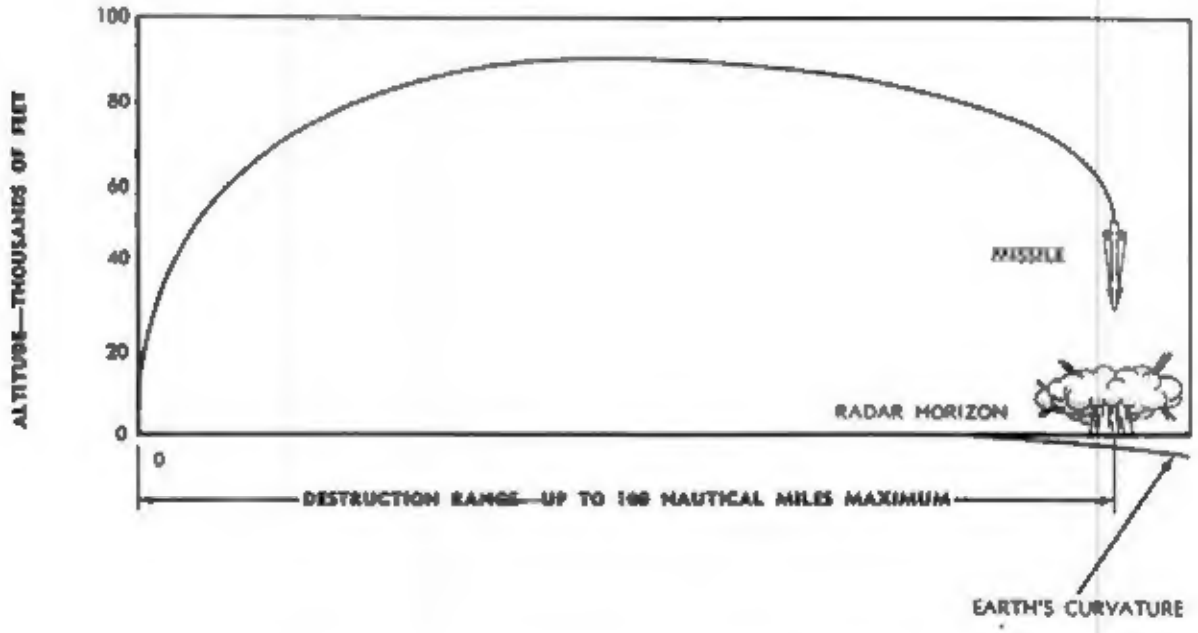

Figure 4 (C). Surface-to-surface mission capabilities (U).

not be made within a "dead zone" surrounding the missile launcher. This "dead zone" has a ground radius of approximately 10,000 yards and an altitude of approximately 20,000 feet. The dead zone is determined by the launch angle and minimum diving radius of the missile. Capabilities of the NIKE–HERCULES ATBM Systems during surface-to-air missions against manned aircraft and air supported missiles are shown in figure 4.1.

b. Surface-to-Air Anti-Missile Mission. When the anti-missile mission is selected, the computer is conditioned for ballistic prediction. The system can guide a NIKE–HERCULES missile to intercept and destroy a tactical ballistic missile traveling at speeds up to 2,380 knots. Figure 4.2 shows the intercept capability of the system during the anti-missile mission.

c. Surface-to-Surface Mission. The NIKE–HERCULES ATBM System can deliver a NIKE–HERCULES missile armed with a nuclear warhead to a surface target at a maximum range of 100 nautical miles. The capabilities of the system during surface-to-surface mission are shown in figure 4.

d. Operating Conditions. Operating conditions for the NIKE–HERCULES ATBM System are identical to those for the Improved NIKE–HERCULES System given in paragraph 8d.

9 (C). Technical Data

a. Missile.

Maximum speed	3650 feet per second at mean sea level.
Maximum altitude	100,000 feet.

b. Acquisition Radar Systems.

(1) *HIPAR.*

Maximum operating range	350,000 yards.
Peak RF power output	4 megawatts.

(1.1) *EFS/ATBM HIPAR.*

Maximum operating range	350,000 yards.
Peak RF power output	7.5 megawatts.

(1.2) *AAR.*

Maximum operating range	350,000 yards.
Peak RF power output	500 kilowatts.

(2) *LOPAR.*

Maximum operating range	250,000 yards.
Peak RF power output	1 megawatt.

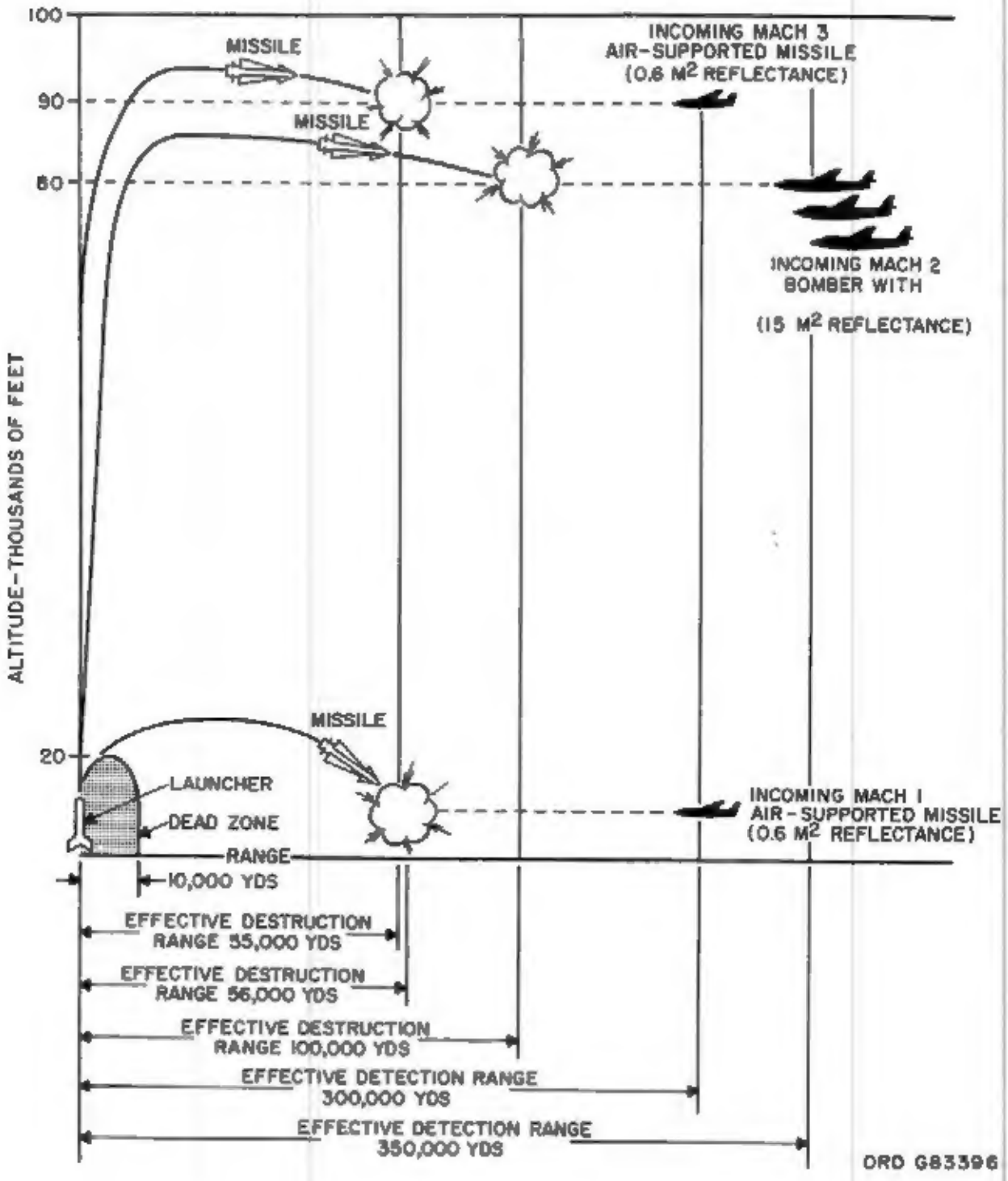

Figure 4.1 (C). Surface-to-air mission capabilities against manned aircraft and air supported missile (U).

c. Target Tracking Radar System.

Maximum operating range ... 200,000 yards.
Minimum operating range ... Under 1000 yards.
Tracking rates:
  Azimuth ... 700 mils per second.
  Elevation ... 700 mils per second (automatic). 65 mils per second (slew).
  Range ... 2000 yards per second (automatic). 18,000 yards per second (slew).
Peak RF power output:
  Short pulse ... 201 kilowatts.
  Long pulse ... 142 kilowatts.

d. Target Ranging Radar System.

Maximum operating range ... 200,000 yards.
Minimum operating range ... Under 1000 yards.
Tracking rates:
  Azimuth ... 700 mils per second.
  Elevation ... 700 mils per second (automatic). 65 mils per second (slew).
  Range ... 2000 yards per second (automatic). 18,000 yards per second (slew).
Peak RF power output ... 125 kilowatts (min.).

e. Missile Tracking Radar System.

Maximum operating range ... NIKE-AJAX 55,000 yards. NIKE-HERCULES 200,000 yards.
Minimum operating range ... Under 1000 yards.
Tracking rates:
  Azimuth ... 750 mils per second.
  Elevation ... 700 mils per second.
  Range ... 1600 yards per second (automatic). 18,000 yards per second (slew).
Peak RF power output ... 140 kilowatts.

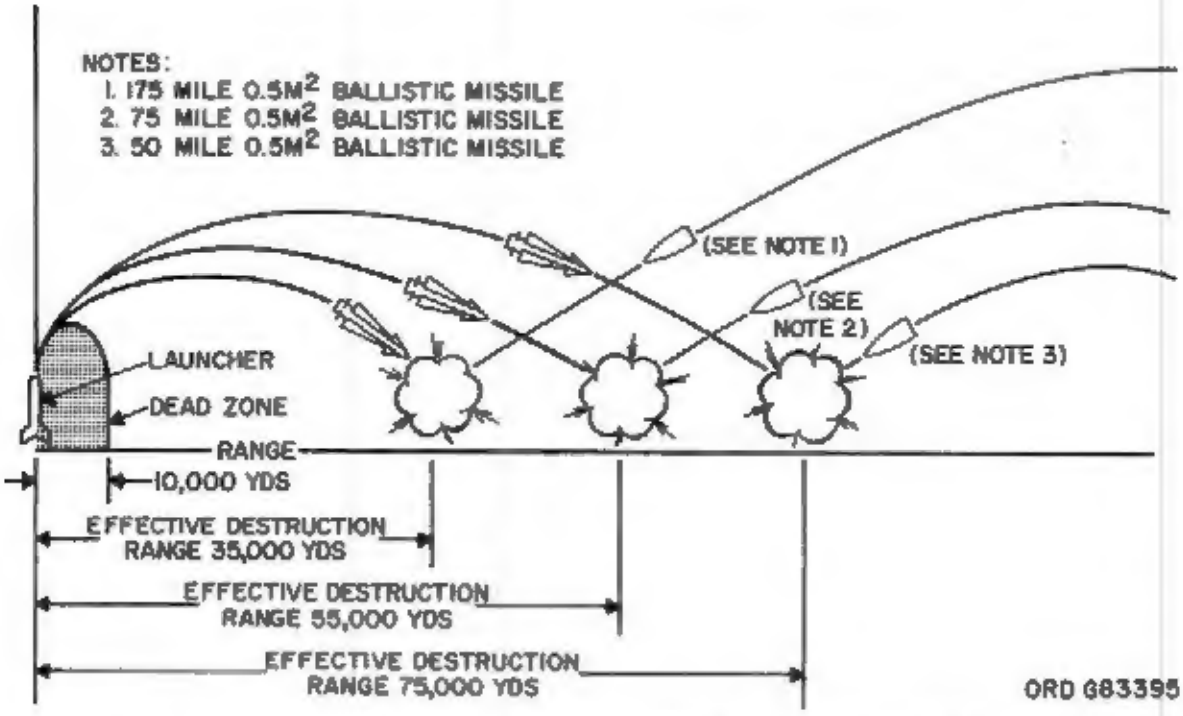

Figure 4.2 (C). Surface-to-air mission capabilities against ballistic missiles (U).